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green one with withered spikes of empty sporangia, another one with matured fruit, and a minute young frond; rootlets profuse, stout, forking dichotomously. Sterile segment undulate, divisions 1-4, sometimes forking once or twice, acutish, pendulous, sinuses wrinkled or plicate. Fertile segments or "spikes" 1-4, arising at intervals or clustered from the stipe, the basal margins, or the intramarginal lamina near the base of the sterile segment, recurved; peduncles 6 lines long, spikes 6 lines to one inch long and one line broad; sporangia 14-20 pairs.

The external structure of the frond in this species as also in *O. pendulum*, indicates the unity of the barren and fertile parts in *Ophioglossaceæ*, and that together they constitute a "branched leaf." (Sachs) This theory is in opposition to the earlier hypothesis of a cohesion of the two spikes of a barren and of a fertile frond. In *O. palmatum*, therefore, the highly developed frond may be described as branching into one barren, and numerous fertile, segments; the former again dividing into dichotomously forking lobes.

Branching thus like the horns of elks, and thick and fleshy in texture while living, this curious epiphyte has probably recalled to others as well as myself, the exotic Fern, which is often seen attached to the wall of conservatories, *Platyserium alcinorne*.

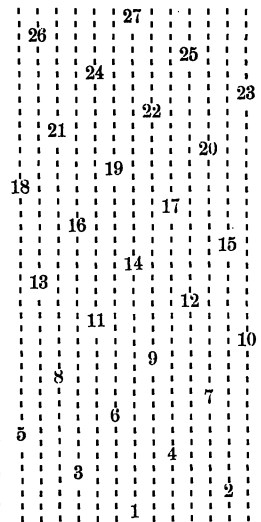
The species is so distinct from all its congeners, that Presl founded upon it a separate genus, which he called *Cheiroglossum*, in allusion to the resemblance of the sterile segment to a *hand*, and of the fertile ones to *tongues*.—JOHN DONNELL SMITH.

PHYLLOTAXY OF LEAVES, by A. P. Morgan (concluded from Feb. GAZETTE).—15. The secondary spirals are of essential service in determining the arrangement of the leaves when they are thickly crowded upon the stem, as is the case with the leaves of the Houseleek and the scales of Pine Cones. The intermediate spirals are the most plainly to be seen; those adjacent to the vertical ranks and to the primary spiral are the most obscure. Having determined two consecutive orders of spirals, one winding to the right and the other winding to the left, the sum of their numbers of spirals gives the next higher order of spirals, and their difference gives the next lower order. The other orders of spirals may be determined in like manner until the primary generating spiral and the vertical ranks are reached.

16. A single example will illustrate the manner of finding the cycle by means of the secondary spirals. Take for example the cone of the White Pine (*Pinus Strobus*) (Figs. 5 and 6). The process of

finding the cycle may be divided into three parts.

I. *To mark the numbers upon the scales.* If we trace one set of spirals plainly to be seen winding to the right, we find they consist of three parallel lines of scales extending from the base to the apex of the cone. This gives us the common difference 3 (14. e.). In like manner from a set of spirals winding to the left, we get the common difference 5. Marking the lowest scale 1, we set off from it in one direction the series 1, 4, 7, 10, &c., and in the other direction the series 1, 6, 11, 16, &c. Then from 4, 7, 10, 13 as starting points, with the common difference 5, we mark parallel with 1, 6, 11, &c., the series of scales, 4, 9, 14, &c., 2, 7, 12, &c., 5, 10, 15, &c., and 3, 8, 13, &c. This numbers all the scales of the cone.



Figs. 5 and 6.

II. *To find the denominator of the cycle.* The number of the spirals in the two consecutive orders is 3 and 5; hence the number of spirals in the next higher order is $3 \times 5 = 8$ (14. c.). This order therefore consists of eight spirals parallel with 1, 9, 17, 25, &c. The sum of 5 and 8 is 13 and an inspection shows that the series 1, 14, 27, 40, &c., belongs to a vertical rank. There are therefore 13 vertical ranks, and the denominator of the cycle is 13.

III. *To find the numerator of the cycle.* If we trace the primary generating spiral 1, 3, 4, 5, &c., from the scale marked 1, we find that it makes 5 turns around the cone to reach the scale marked 14. This gives the numerator 5. Therefore the cycle is 5-13.

17. That the cycle of the cone belongs to the common system (0-1, 1-2, etc.) may be inferred from the number of spirals in the successive orders being 3, 5, 8, 13, (14. b. c.). The numerator 5 of the cycle may also be inferred from the second order of spirals preceding the vertical rank. The numerator of any cycle in the common system is always the same as the denominator of the second preceding cycle, and, consequently the same as the next higher order of secondary spirals.

18. The number of cycles in a Pine cone may be indicated by prefixing a multiplier to the fraction expressing the cycle. This will also show approximately the number of scales in the cone. Thus the cycle and number of cycles in a cone of Hemlock Spruce (*Abies Canadensis*) is represented by 2 (5-13). This also shows that the number

of scales in the cone is $2 \times 13 = 26$. The number of cycles in the cones of Black spruce (*Abies nigra*) vary from 4 to 7, averaging about 5. Hence its cycle and the number of cycles will be represented by

TABLE II.

C	I	II	III	IV	V	VI	VII
	1	2	3	5	8	13	21
0-1	0						
1-2	1						
1-3	1	1-2					
2-5	2	1-2	1-3				
3-8	3	1	1-3	1-5			
5-13	5	3-2	2-3	1-5	1-8		
8-21	8	5-2	1	2-5	1-8	1-13	
13-34	13	4	5-3	3-5	1-4	1-13	1-21

5 (5-13), and the number of scales by $5 \times 13 = 65$. In like manner the cone of White Pine (*Pinus Strobus*) is represented by 5 (5-13); of Pitch Pine (*Pinus rigidus*) by 4 (13-34); of American Larch (*Larix Americana*) by 2 (2-5), etc.

19. Table II exhibits the number of turns or parts of a turn made by each order of spirals in a single cycle. Or, the denominator shows the number of cycles required for

the spirals to make the number of turns indicated by the numerator.

Opposite Leaves.—20. Opposite leaves also exhibit cycles of arrangement analogous to those of alternate leaves.

21. *The 0-2 Cycle*.—(Fig. 7.) The 0-2 cycle represents the two-leaved ancestor of all Dicotyledons; it yet stands for the cotyledonary leaves of many of them, the succeeding leaves being alternate. The 0-2 cycle, however, is not at all liable to the objection of being an ideal one. "In many fossil plants the pairs of leaves do not alternate, but are placed directly one over the other." (Hensley's Elementary Botany, p. 45.) Hence 0-2 represents a two-ranked arrangement of opposite leaves.

22. *The 1-4 Cycle*.—(Fig. 8.) In the case of opposite decussate leaves, the cycle is complete in two nodes. The leaves are borne upon two spirals, each of which makes half a turn round the stem. The cycle, therefore, is represented by $2(1-2)-2(2)=1-4$. This is the most common arrangement of opposite leaves. Examples are furnished by the Maple, and by plants of the Mint Order.

23. *The Higher Cycles*.—When the fourth pair of leaves stands directly over the first pair, three nodes complete the cycle and there are six ranks. There are two spirals each bearing three leaves in half a turn about the

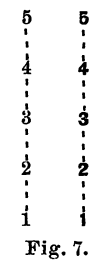


Fig. 7.

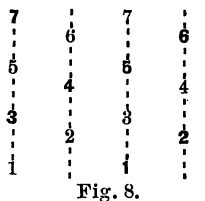


Fig. 8.

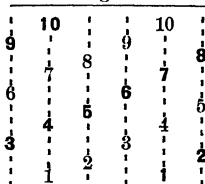


Fig. 9.

stem. This cycle then is represented by $2 (1-2) -2 (3) = 1-6$. (Fig. 9.) In like manner it may be shown that the next cycle, in which the 6th pair of leaves stands directly over the first pair, is represented by $2 (1)-2 (5) = 2-10$. And it will be found that the cycles of opposite leaves are represented by the series, 0-2, 1-4, 1-6, 2-10, 3-16, 5-26, 8-42, &c.

24. The following table exhibits the number and direction of all the orders of spirals belonging to each cycle of opposite leaves, as far as the 13-68 cycle.

TABLE III.

C	I	II	III	IV	V	VI	VII
0-2	0						
1-4	+2						
1-6	+2	-4					
2-10	+2	-4	+6				
3-16	+2	-4	+6	-10			
5-26	+2	-4	+6	-10	+16		
8-42	+2	-4	+6	-10	+16	-26	
13-68	+2	-4	+6	-10	+16	-26	+42

will be found that two sets of numbers are necessary to mark all the scales of the cone.

26. In like manner cycles of verticillate leaves when there are three leaves at each node will fall into the series 0-3, 1-6, 1-9, 2-15, &c. When there are four leaves at each node the series will be 0-4, 1-8, 1-12, 2-20, &c.

TABLE IV.

SYSTEM.	ORDERS OF SPIRALS.						
	I	II	III	IV	V	VI	VII
(0-1, 1-2)	+1	-2	+3	-5	+8	-13	+21
(0-1, 1-3)	+1	-3	+4	-7	+11	-18	+29
(0-1, 1-4)	+1	-4	+5	-9	+14	-23	

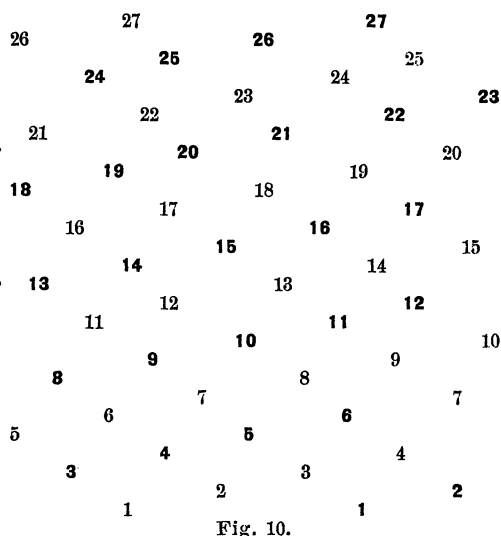


Fig. 10.

25. Exceptional cones of Pine and Fir are to be met with, which belong to the higher cycles of opposite leaves. Fig. 10 is a cone of Black Spruce, in which the cycle is 5-26. The cycle of such a cone is to be determined in the same way as one belonging to the alternate system (16.), except that in numbering the scales the common difference is found by taking half the number of spirals in each order. It

27. There is authority for examples of cycles in systems other than the common one.

Table IV exhibits three systems of cycles and the number and direction of their different orders of

spirals. The laws (13, 14) that govern the common system apply equally to any other. The mode of finding the cycle from the secondary spirals (15, 16) is also the same as in the common system.

28. The phyllotaxis of the leaves is generally uniform in the same species. Thus in the Oak the leaves are always alternate; in the Maple, they are always opposite; and in *Galium* always whorled. The cycle of the cone of Hemlock Spruce is always 5-13. The direction of the spirals does not appear to be uniform in the same species, but, in some individuals the spiral winds to the right, and in others it winds to the left. In the same individual plant, the spiral usually pursues the same direction upon the branches as upon the stem.

FLOWERS AND SNOW.—This season of the year calls to mind some observations concerning flowers and snow in Colorado.

Among the first flowers of spring, those that must live and bloom through many snow storms, are *Townsendia sericea*, *Sisymbrium canescens*, *Cymopterus glomeratus* and *montanus*, *Viola Nuttallii*, *Leucocrinum*, *Corydalis*, *Thlaspi*, &c. Last year the *Townsendia* was in blossom as early as Feb. 14th, and *Phlox canescens*, with many other flowers, by the middle of March. A number of plants are in bloom in April and covered every year by the spring snows. In May I have seen *Cratægus coccinea* white with flowers made still whiter by the damp snow, with *Astragalus* and *Vicia* and very many other plants in full bloom buried beneath a foot of snow.

The spring snows do not seem to injure the plants or flowers in the least and many of them are benefited by the increase of moisture.

A snow storm in June is said to have covered all the dry parks with sunflowers, *H. petiolaris* and *lenticularis*. The alpine plants growing where there is a frost nearly every night in the year, must be well able to stand the cold. In July I once saw a *Trollius laxus* in blossom, growing out from a hole about one foot in diameter, in the center of a large snow drift. As the snow drifts disappear the plants rapidly grow and blossom. Some of the drifts melt away much sooner than others, and plants growing there are much in advance of those inhabiting the place of late melting snows. On Mt. Ouray, above timber line, there is a slope which, in August, is beautifully covered with the large golden flowered *Ranunculus adoneus*. On one portion from which the snow early melted, the plants are almost out of flower; at another part they are in their greatest perfection, and in other parts they are in their youth, closely following up the retreating snow drift.